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A FILTER USED FOR DISPLAY DEVICES AND THE DISPLAY DEVICE

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A FILTER USED FOR DISPLAY DEVICES AND THE DISPLAY DEVICE

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[There are no amendments to this patent.]

(54) [Title of the invention]

A filter used for display devices and the display device

(57) [Abstract] (Rewritten)

[Objective] The objective of the present invention is to produce an antireflective filter for display devices which has excellent soil resistance, scratch resistance, and fabrication resistance.

[Problem solving] An antireflective filter used for display devices, in which the surface of a single layer or multilayer antireflective film 2 having a surface film mainly consisting of silicon dioxide deposited on plastic substrate 1 is coated with alkoxysilane layer 3

containing the fluoroalkyl group or perfluoropolyether group shown in general formula (I) below.



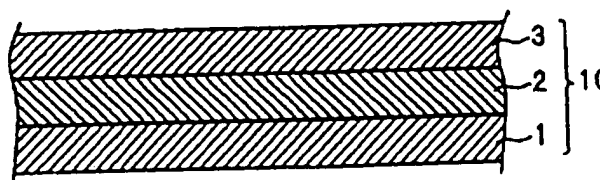
(wherein, R_f is a fluoroalkyl group or perfluoropolyether group, X is a bonding atom or bonding group, R_1 is a carbon chain containing an alkylene group and R_2 is an alkyl group or a carbon chain containing an alkyl group.)

1: Plastic substrate

2: Antireflective film

3: Surface modified film

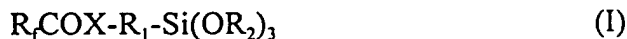
10: Filter



[Claims of the invention]

[Claim 1] An antireflective filter used for display devices in which film the surface of a single layer or multilayer antireflective film having a surface film mainly consisting of silicon dioxide deposited on a plastic substrate is coated with an alkoxysilane containing the fluoroalkyl group or perfluoropolyether group shown in general formula (I).

[Chemical formula 1]



(wherein, R_f is a fluoroalkyl group or perfluoropolyether group, X is a bonding atom or bonding group, R_1 is a carbon chain containing an alkylene group and R_2 is an alkyl group or a carbon chain containing an alkyl group.)

[Claim 2] The antireflective filter used for displays described in claim 1, in which the above-mentioned alkoxysilane is an alkoxysilane containing a perfluoropolyether group, and a solution produced by diluting the above-mentioned compound with a solvent having a boiling point in the range of 50~120°C and viscosity in the range of 0.5~4.0 cps at 20°C is coated onto the surface of the antireflective film to form a surface-modification film.

[Claim 3] The antireflective filter used for displays described in claim 1, in which the surface of the above-mentioned antireflective film mainly consists of silicon dioxide and a surface-modification film is formed on said surface.

[Claim 4] A display having an antireflective filter, in which the surface of a single layer or multilayer antireflective film having a surface film mainly consisting of silicon dioxide deposited on a plastic substrate is coated with an alkoxysilane having a fluoroalkyl group or perfluoropolyether group shown in general formula (I).

[Chemical formula 2]



(wherein, R_f is a fluoroalkyl group or perfluoropolyether group, X is a bonding atom or bonding group, R_1 is a carbon chain containing an alkylene group and R_2 is an alkyl group or a carbon chain containing an alkyl group.)

[Claim 5] The display described in claim 4, in which the above-mentioned alkoxysilane is an alkoxysilane containing a perfluoropolyether group, and a solution produced by

diluting the above-mentioned compound with a solvent having a boiling point in the range of 50~120°C and a viscosity in the range of 0.5~4.0 cps at 20°C is coated onto the surface of the antireflective film to form a surface-modification film.

[Claim 6] The display described in claim 4, in which the surface of the above-mentioned antireflective film consists mainly of a silicon dioxide and a surface-modification film is formed on said surface.

[Detailed explanation of the invention]

[0001]

[Technical field of the invention] The present invention pertains to an antireflective filter used for displays which filter has excellent soil resistance, scratch resistance, and fabrication resistance, and the invention further pertains to a filter that can be used for the front surface of CRT's, etc. and a display with said filter.

[0002]

[Prior art] When the reflected light is too intense and the reflected image is well defined when the objective is observed through a transparent material, for example, in the case of the lenses used for eyeglasses, reflected images commonly referred to as ghosts or flare light cause an unpleasant effect on the eyes. Furthermore, in the case of looking glasses, etc., the image cannot be seen clearly due to reflections from the glass.

[0003] In the past, a method wherein a material having an index of refraction different from that of the substrate has been deposited on the surface of the substrate by means of vapor deposition, etc. to prevent reflection. In this case, in order to achieve a

maximum antireflection effect, it is known that the thickness of the material used for coating the substrate is important.

[0004] For example, in the case of a single layer coating, it is known that the minimum reflectivity, in other words, the maximum transmittance can be achieved when an optical thickness of the material having a lower index of refraction than that of the substrate is selected to be $1/4$ that of the target optical wavelength or an odd multiple thereof. In this case, optical thickness means the product of the index of refraction of the film-forming material and the thickness of said film-forming material. Furthermore, it is possible to form multilayer antireflective films, in which case, a few ratios are available for selection of the film thickness (*Optical Technology Contact*, Vol. 9, No. 8, p. 17 (1971)).

[0005] Meanwhile, methods used for formation of multilayer antireflective films that satisfy the above-mentioned optical film thickness conditions using a liquid composition are described in Japanese Kokai Patent Application No. Sho 58-46301, Japanese Kokai Patent Application No. Sho 59-49501, and Japanese Kokai Patent Application No. Sho 59-50401. In recent years, from the standpoint of lightness of weight, safety, and handling ease, optical products having antireflective properties made on a plastic substrate are being designed and used in practice. And a film structure having a silicon dioxide surface layer film has been adopted in many cases.

[0006]

[Problems to be solved by the invention] The film coating material used for antireflective films produced by the deposition method mainly consist of inorganic oxides or inorganic halides, and when a plastic substrate is used, the antireflective film has a high basic surface

hardness, but soiling due to hand smudges, fingerprints, sweat, hair lotion, and hair spray, etc. are difficult to remove. Furthermore, the slipperiness of the surface is inadequate, thus, problems such as an increase in the thickness of scratches results. In addition, the wettability with water is high, thus, rain drops or water droplets spread and the area of distortion of the object increases for eyeglasses, etc.

[0007] In order to achieve high surface hardness in the antireflective film described in publications such as Japanese Kokai Patent Application No. Sho 58-46301, Japanese Kokai Patent Application No. Sho 59-49501 and Japanese Kokai Patent Application No. Sho 59-50401, it is necessary to include at least 30 wt% of an inorganic material such as fine silica particles, in the upper-most layer of the film, but the slipperiness is inadequate in antireflective films produced with the above-mentioned film composition, and scratches are likely to form as a result of abrasion when wiped with a cloth, etc.

[0008] In order to solve the above-mentioned problems, many different types of surface treatment agents have been suggested and are being marketed, but all are soluble in water or various types of solvents, thus, only a temporary effect can be provided and a long-term effect cannot be achieved. Furthermore, a method wherein a fluororesin layer is formed to provide water repellency is reported in Japanese Kokai Patent Application No. Hei 3-266801. Water repellency certainly can be achieved with the above-mentioned fluororesin, but the effect remains inadequate with regard to friction and abrasion resistance.

[0009] The present invention is based on the above background, and the objective of the present invention is to produce an antireflective filter for display devices which filter

has excellent soil resistance, scratch resistance, and fabrication resistance, and a display made with said filter.

[0010]

[Means to solve the problem] As a result of much research carried out by the inventors in an effort to eliminate the above-mentioned problems, the present invention was accomplished. Thus, the present invention is an antireflective filter used for display devices, in which filter the surface of a single layer or multilayer antireflective film having a surface film mainly consisting of silicon dioxide deposited on a plastic substrate is coated with an alkoxysilane having a fluoroalkyl group or perfluoropolyether group shown in general formula (I).

[0011]

[Chemical formula 3]



(wherein, R_f is a fluoroalkyl group or perfluoropolyether group, X is a bonding atom or bonding group, R_1 is a carbon chain containing an alkylene group and R_2 is an alkyl group or a carbon chain containing an alkyl group.)

In the present invention, the surface of the above-mentioned antireflective film mainly consists of silicon dioxide and a surface-modification film is formed on the surface.

[0012] In the filter of the present invention, it is desirable when the alkoxysilane is an alkoxysilane containing a perfluoropolyether group, and a solution produced by diluting the above-mentioned compound with a solvent having a boiling point in the range of

50~120°C and a viscosity in the range of 0.5~4.0 cps at 20°C is coated onto the surface of the antireflective film to form a surface-modification film.

[0013]

[Work of the invention] During many studies carried out for the above-mentioned problems, the inventor found friction and soil resistance can be improved when a surface treatment with a perfluoropolyether is provided. However, it was further found that properties such as chemical resistance during treatment with a solvent, for example, is dramatically reduced despite the excellent results achieved through the above-mentioned surface treatment with the compound. It is hypothesized that the interaction with SiO_2 on the surface is responsible.

[0014] Thus, further studies were carried out by the inventors, and as a result, they found that problems of wear resistance and resistance to soiling of antireflective filters used for displays can be solved when coating is done with an alkoxysilane containing a fluoroalkyl group or perfluoropolyether group shown in general formula (I).

[0015] In other words, in order to achieve an interaction with the surface of the SiO_2 , an alkoxysilane structure is included in the structure and firm bonding is achieved on the surface. As a result, existing problems such as inadequate solvent resistance can be eliminated. Furthermore, when a fluorine-containing group is included in the molecule of the alkoxysilane shown in general formula (I) of concern in the present invention, water repellency can be increased and resistance to soiling can be increased.

[0016] Furthermore, among the compounds represented by general formula (I), an alkoxysilane having a fluoroalkyl group can be used satisfactorily from the standpoint of

the above-mentioned solvent resistance and resistance to soiling, but compared with an alkoxysilane having a perfluoropolyether group in the molecule structure which provides superior tribological characteristics, the wear resistance and friction properties are inadequate; thus, the latter compound is especially desirable.

[0017] Furthermore, coating irregularities are likely to form after coating when an alkoxysilane having a perfluoropolyether group is used, which may lead to problems such as inadequate resistance to soiling and poor surface appearance. Coating properties are influenced by the boiling point of the solvent. Thus, it is said that the rate of drying of the solvent is approximately 1 $\mu\text{m/s}$ for those with a boiling point of 70°C, and drying after coating may pose a problem for solvents with a high boiling point, and it is reported that coating irregularities due to retention of the solvent at the time of drying are likely to occur for those solvents with a low boiling point (*IEEE Trans MAG.*, Vol. 31, No. 6 (1995) pp. 2982~2984). Furthermore, a high proportion [of solvent] is coated at the time of lifting during dip coating or addition of the solution during gravure coating when the viscosity is high, as a result, drying is likely to be inadequate. Furthermore, the Reynolds number (see the mathematical formula below for reference) is inversely proportional to the viscosity of the solvent at the time of coating, thus, coating irregularities are likely to form when the viscosity is too low. For this reason, there is a possibility that the optimum value can be achieved from the standpoint of the boiling point and viscosity of the solvent.

[0018]

[Mathematical formula 1] (Reynolds number) = vl/η

(Wherein, v is the take-up rate and l is the height of the meniscus at the time of take-up, and η is the viscosity.) Based on the above background and further research carried out by the inventors, it was found a lubricating film having a uniform thickness can be produced when the compound is coated with a solution diluted with a solvent having a boiling point in the range of 50~120°C and a viscosity in the range of 0.5~4.0 cps at 20°C when the alkoxysilane is an alkoxysilane containing a perfluoropolyether group.

[0019]

[Embodiment of the invention] In the following, the present invention is explained in further detail based on the embodiment. Fig. 1 shows a cross section of the filter used for displays of one embodiment of the present invention.

[0020] In the filter 10 used for displays of the embodiment shown in Fig. 1, antireflective film 2 is formed on one surface of plastic substrate 1 and surface-modification film 3 is further formed on the above-mentioned surface. Filter 10 of the above-mentioned embodiment is bonded to, for example, the surface of panel 101 of the cathode ray tube (CRT) shown in Fig. 2 with an adhesive. The adhesive used for bonding the substrate of filter 10 to panel 101 is not especially limited and a variety of conventional adhesives can be used, and in general, an ultraviolet-curable adhesive resin having an index of refraction close to the index of refraction of the cured layer is used. For example, it is desirable for the difference in the index of refraction to be 0.8% or less. In specific terms, a composition consisting of 10 wt% of a bisphenol A type epoxy (meth)acrylate with a molecular weight of at least 220, 20 wt% of urethane (meth)acrylate, 70 wt% of

mono(meth)acrylate containing an hydroxyl group, 3% of a photopolymerization initiator and several % of other additives, for example, can be used.

[0021] In the present invention, the plastic substrate 1 used for the filter 10 shown in Fig. 1 is not especially limited, and a substrate made of any organic polymer can be used, but from the standpoint of optical properties such as transparency, index of refraction, and dispersibility, as well as impact resistance, heat resistance, and wear resistance, etc., (meth)acrylate type resins such as polymethyl methacrylate, copolymers of methyl methacrylate and other alkyl (meth)acrylates or vinyl monomers such as styrene, polycarbonate type resins such as polycarbonate and diethylene glycol bisallyl carbonate (CR-39), thermo-curable (meth)acrylate type resins such as homopolymers or copolymers of di(meth)acrylate of (brominated) bisphenol A, polymers and copolymers of urethane-modified monomers of mono(meth)acrylate of (brominated) bisphenol A, polyethylenes, in particular, polyethylene terephthalate, polyethylene naphthalate and unsaturated polyethylene, acrylonitrile-styrene copolymers, polyvinyl chloride, polyurethane, epoxy resins, etc. are desirable. Furthermore, considering heat resistance, it is possible to use an aramid type resins. In this case, the upper limit of the heat treatment temperature becomes 200°C or higher, and an increase in the temperature range can be expected.

[0022] Furthermore, the surface of the above-mentioned plastic substrate can be coated with a film material such as a hard coat, and properties such as adhesion, hardness, chemical resistance, wear resistance and dye affinity can be increased further when the above-mentioned film is included underneath the antireflective film made of an inorganic material described below.

[0023] For improvement of the degree of hardness, many different types of films commonly used as films for improving the hardness of plastics can be used in this case, as well, and, for example, techniques such as those disclosed in publications such as Japanese Kokoku Patent Application No. Sho 50-28092, Japanese Kokoku Patent Application No. Sho 50-28446, Japanese Kokoku Patent Application No. Sho 51-24368, Japanese Kokai Patent Application No. Sho 52-112698 and Japanese Kokoku Patent Application No. Sho 57-2735 can be used. Furthermore, an acrylic type crosslinked material made of (meth)acrylate and a crosslinkable materials such as pentaerythritol, or organopolysiloxanes can be used as well. The above-mentioned materials can be used independently or in appropriate combinations.

[0024] The above-mentioned antireflective film 2 formed on the upper part of plastic substrate 1 can be a single layer or it can have a multilayer structure, and many different combinations can be used. Furthermore, when used in the form of a multilayer structure, the film structure of the material that forms the lower layer of the surface film can be appropriately determined according to the properties required, for example, heat resistance, antireflective properties, color of the reflection, wear resistance, surface hardness, etc.

[0025] As a method of film formation used for inorganic materials that includes the silicon dioxide that forms the above-mentioned antireflective film, many different types of PVD (Physical Vapor Deposition) represented by vacuum deposition, ion plating, sputtering, etc. can be mentioned. For examples of inorganic materials that can be effectively used for the above-mentioned PVD method in production of the antireflective film, in addition to SiO_2 , inorganic oxides such as Al_2O_3 , ZrO_2 , TiO_2 , Ta_2O_5 , TaHf_2 , SiO ,

TiO, Ti₂O₃, HfO₂, ZnO, In₂O₃/SnO₂, Y₂O₃, Yb₂O₃, Sb₂O₃, MgO and CeO₂, for example, can be mentioned. Furthermore, it is desirable for the outer-most layer of the antireflective film produced by the above-mentioned PVD method to be mainly composed of silicon dioxide. When a material other than silicon dioxide is used, it is not possible to achieve an adequate surface hardness; furthermore, the target properties of the present invention such as resistance to soiling, scratch resistance and long-lasting effect of the above-mentioned properties cannot be achieved. However, the present invention mainly pertains to a structure consisting of a surface-modification film that covers the above-mentioned antireflective film; thus, the material used for the outer-most layer for the antireflective film is not especially limited and a material other than silicon dioxide can be used as well.

[0026] Furthermore, the thickness of the film used for the outer-most layer is determined according to properties required other than the antireflective effect, and in order to maximize the antireflective effect, it is desirable for the optical film thickness of the material having a lower index of refraction than that of the substrate to be 1/4 of the target optical wavelength or an odd multiple thereof.

[0027] On the other hand, the structure used for layers below the above-mentioned surface layer film is not especially limited. In other words, it is possible to form the above-mentioned surface layer film directly on the substrate, and in order to achieve a higher antireflective effect, it is effective to use at least one layer of a film having an index of refraction higher than that of the surface layer film on the substrate. A few proposals are made regarding the film thickness and selection of the index of refraction in multilayer antireflective films (for example, *Optical Technology Contact* Vol. 9, No. 8, p.17 (1971)).

[0028] Furthermore, it is possible to form an inorganic light-transmitting film such as a carbon sputtering film and a carbon CVD film to be used for the lower layer. And in the present invention, the surface of the above-mentioned single layer or multilayer antireflective film 2 is coated with a surface-modification film made of an alkoxysilane containing the fluoroalkyl group or perfluoropolyether group shown in the following general formula (I).

[0029]

[Chemical formula 4]

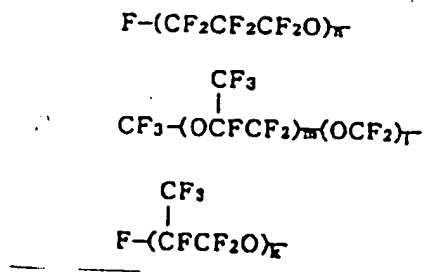


(wherein, R_f is a fluoroalkyl group or perfluoropolyether group, X is a bonding atom or bonding group, R_1 is a carbon chain containing an alkylene group and R_2 is an alkyl group or a carbon chain containing an alkyl group.)

The molecular structure of the perfluoropolyether group represented by R_f is not especially limited, and perfluoropolyether group with many different chain lengths are induced, and a perfluoropolyether having a perfluoroalkyl oxy group of approximately $C_1\sim C_3$ as a repeating unit is especially desirable in this case, and in specific terms, those shown below can be mentioned for monofunctional type groups.

[0030]

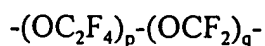
[Chemical formula 5]



[0031] For polyfunctional type, those shown below can be mentioned.

[0032]

[Chemical formula 6]



[0033] It should be noted that l, m, n, k, p and q in the above chemical structure each represent integers of 1 or higher. As described above, the molecular structure of the perfluoropolyether is not limited to the above-mentioned examples. Furthermore, the molecular structure of the fluoroalkyl group shown in R_f is not especially limited, and fluoroalkyl group with many different chain lengths and degrees of fluorine substitution can be used and an fluoroalkyl group of approximately C₅~C₁₂ is especially desirable in this case.

[0034] Furthermore, from the standpoint of the above-mentioned excellent wear resistance and friction resistance, it is desirable when perfluoropolyether group is used for

R_f. The bonding atom represented by X in general formula (I) is not especially limited, but in general, an atom or group such as O, NH, or S is used.

[0035] Furthermore, the number of carbon atoms of R₁ and R₂ in general formula (I) is not especially limited, and a straight-chain carbon atoms chain of approximately C₁~C₅ can be used. Furthermore, a cyclic structure such as unsaturated bonds, characteristic group, and aromatic ring can be used as a part as long as the flexibility and fluctuation characteristics of the above-mentioned carbon chain is not impaired; furthermore, a short branched-chain or side-chain can be included as well.

[0036] In addition, the molecular weight of the compound shown in general formula (I) above is not especially limited, and from the standpoint of safety and ease of handling, those with a number average molecular weight in the range of 500~10000, preferably in the range of 500~4000, can be used effectively. Furthermore, the thickness of the surface-modification film formed with the above-mentioned compound is not especially limited, and from the standpoint of the balance between the antireflective properties and static contact angle with water, and surface hardness, a film thickness in the range of 0.5 nm~50 nm is desirable and in the range of 1 nm~10 nm is especially desirable.

[0037] As for the coating method used in this case, many different methods used for standard coatings can be used in this case as well, and from the standpoint of controlling the uniformity and thickness of the film, spin coating, dip coating and curtain flow coating can be used effectively. Furthermore, from the standpoint of performance, coating methods wherein the solution is impregnated in a paper cloth, etc. and casting is further performed can be used effectively.

[0038] In the above-mentioned coating process, in general, the compound shown in general formula (I) is diluted with a volatile solvent. The solvent used in this case is not especially limited, and the type of solvent used is determined taking factors such as wettability of the upper-most layer of the antireflective film that forms the coating surface, specifically, the silicon dioxide film, volatility, etc. into consideration. An alcohol-type solvent is especially desirable in the present invention.

[0039] For the dilution solvent, one with a boiling point in the range of 50°C~120°C and viscosity in the range of 0.5~4.0 cps at 20°C are desirable, and when dilution is performed with the solvent that satisfies the above-mentioned conditions and coating is performed, a film with a uniform thickness can be produced. For examples of the above-mentioned alcohol-type solvent that satisfies the above-mentioned conditions, methanol, ethanol, n-propanol, i-propanol, n-butyl alcohol, i-butyl alcohol, sec-butyl alcohol, sec-amyl alcohol, etc. can be mentioned. Furthermore, for the dilution solvent, one or a mixture of two or more different types of solvents can be used in combination.

[0040] The degree of dilution with the dilution solvent used upon production of the coating solution of the compound shown in general formula (I) is not especially limited, and a concentration of approximately 0.1~5.0 wt% is suitable. Furthermore, it is possible to add an acid or an alkali to the above-mentioned coating solution as a reaction catalyst, as needed. For an acid catalyst, sulfuric acid, hydrochloric acid, nitric acid, phosphoric acid, acid clay, iron oxide, boric acid, trifluoroacetic acid, etc. can be used and for an alkali catalyst, an alkali metal oxide such as sodium hydroxide, potassium hydroxide, or lithium hydroxide can be used. Furthermore, a phosphate-type catalyst or a carbonyl compound

such as acetyl acetone can be added and the catalytic performance can be increased further. When a catalyst is added, the interaction between the silano group included in the compound shown in general formula (I) and the SiO_2 on the surface of the antireflective film that accompanies the bonding reaction can be promoted without a heat treatment. Thus, a significant increase in wear resistance can be expected in the thin film material on the SiO_2 despite a strong requirement for wear resistance despite the thickness of the film.

[0041] Upon coating the compound shown in general formula (I) of concern in the present invention, it is desirable when the surface of the antireflective film to be coated has been cleaned ahead of time, and upon cleaning, removal of soil deposits using a surfactant, degreasing with an organic solvent, vapor-cleaning with a fluorine-type gas, etc. can be used. Furthermore, in order to improve adhesion and wear resistance, it is desirable to provide a variety of pre-treatments, and as an especially suitable method, treatment with an activated gas, or a chemical treatment with an acid or an alkali, etc. can be mentioned.

[0042] The antireflective filter used for displays produced by the present invention is less likely to become soiled compared with standard antireflective films and soiling is inconspicuous. Furthermore, the soil deposits can be easily removed. In addition, because of the excellent slipperiness of the surface, scratches are less likely to form; furthermore, high wear resistance can be achieved, as well.

[0043] It should be noted that the present invention is not limited to the above-mentioned embodiment and various degrees of modification within the range of the present invention can be carried out. For example, in the above-mentioned embodiment, filter 10 is bonded to panel 101 of CRT 100 shown in Fig. 2, but it is not necessary for filter 10 of the

present invention to be bonded to the surface of the panel and the filter can be a removable filter used for the front surface of panel 101.

[0044] Furthermore, it is not necessary for the panel of the display onto which the filter is to be attached to have curvature as in the case of the CRT and in addition to the panel used for a flat surface such as liquid crystal display and plasma display, it can be used as the panel for many different types of displays. The filter of concern in the present invention can be applied to the panel of the above-mentioned display with an adhesive, etc., or mounted in such a manner that installation and removal can be done easily is possible. In which case, a frame is installed around the perimeter of the filter of the present invention and the filter of the present invention is installed in the frame under tension.

[0045] Furthermore, the multilayer structure of the filter of the present invention is not limited to the structure shown in Fig. 1 and many different multilayer structures can be used.

[0046]

[Application examples] In the following, the present invention is explained further in specific terms with application examples but the present invention is not limited to these application examples, by any means. It should be noted that "parts" in the following application examples refers to parts by weight.

[0047] Application Example 1

(1) Production of antireflective film

A transparent polyethylene terephthalate (PET) film with a thickness of 100 μm was used as the substrate. A hardcoat treatment was performed for one surface of the above-

mentioned PET film to guarantee the required surface hardness, and an ITO with a thickness of 120 nm was pre-deposited onto the above-mentioned surface as an antireflective film by means of vapor deposition, and an SiO₂ film was further deposited to form a thickness of 70 nm. Furthermore, in general, a hardcoat treatment in this case was performed by coating an acrylic type crosslinking raw material resin and curing with ultraviolet or an electron beam, or coating with a silicon type, melamine type, or epoxy type raw material resin and providing a heat treatment.

(2) Production of a coating composition containing an alkoxysilane having a perfluoropolyether group

200 parts of methyl alcohol was added to 4 parts of perfluoropolyether group having a perfluoropolyether group (1) (molecular weight of approximately 1000, see Table I for reference) to mix, 1 cc of acetyl acetone and 0.01 cc of concentrated hydrochloric acid also were added to produce a uniform solution. Subsequently, filtration was performed with a membrane filter to produce the coating composition.

(3) Coating and drying

Dip coating was performed for the surface of the antireflective film produced in (1) above with the coating composition produced in (2) at a lifting rate of 5 cm/min, air drying was subsequently performed to produce an optical product having antireflective properties. In this case, temperature control was not applied during the coating and drying process.

(4) Evaluation of performance

An evaluation was performed for the performance of the optical product produced above according to the test methods described below. The test results for evaluation items (a)

through (e) shown below are shown in Table II. Furthermore, in order to examine the solvent resistance, the same test was performed after cleaning with ethanol. The results obtained are also shown in Table II.

[0048] (a) Stain resistance test

5 ml of city water was applied dropwise to the surface of the filter, and left standing at room temperature ($25^{\circ}\text{C} \pm 2^{\circ}\text{C}$) for 48 hours; subsequently the surface was wiped clean with a cloth and the water marks left behind were visually examined. The result was defined as very good when it was possible to remove the water mark, and inadequate when removal was not possible.

[0049] (b) Surface slipperiness

An evaluation was performed for scratches when the scratch test was performed for the surface with a pencil (hardness 3H). Criteria are as shown below.

O: No scratches are observed.

Δ : Scratches are formed when the force applied is high.

x: Scratches are formed even when the force applied is low.

(c) Wear resistance test

Steel wool #0000 was rubbed 30 times across the surface of the optical product under a load of 200 g and the evaluation was performed based on scratches formed. The criteria are as shown below.

[0051]

O: No scratches are formed.

Δ : Fine scratches are formed.

x: Obvious scratches are formed.

(d) Conspicuousness of hand smudges

The conspicuousness of hand smudges was evaluated visually. Criteria are as shown below.

[0052]

○: Hand smudge is inconspicuous.

△: Hand smudge can be easily removed.

x: Hand smudge is obvious.

(e) Contact angle

The contact angle with water and methylene iodide was measured. The measurement was performed with a CA-A produced by Kyowa Kaimen Kagaku Corp. It should be noted that the value of the measured contact angle is used as the standard for the residual ratio of the surface-modification film or degree of soiling by water or oil.

Application Example 2

In Application Example 1, instead of solvent 1 (methanol) used as the solvent in production of the coating composition containing an alkoxysilane having a perfluoropolyether group, solvent 2 (ethanol) was used as shown in Table II and an optical product was produced as in Application Example 1. An evaluation was carried out for the performance of the optical product produced and the results obtained are shown in Table II.

Application Examples 3~8

In application Example 1, the combination of the solvent and alkoxysilane used in production of the coating composition containing an alkoxysilane having a perfluoropolyether group was changed as shown in Table II and optical products were produced as in Application Example 1. The performance of the optical products produced

was evaluated and the results obtained are shown in Table II. Furthermore, the alkoxysilanes used are shown in Table I and the solvents used are shown in Table III.

Comparative Examples 1~4

In Application Example 1, in the production of the coating composition containing an alkoxysilane having a perfluoropolyether group, the combination of solvent used and the alkoxysilane were changed as shown in Table II and optical products were produced as in Application Example 1. The results obtained are shown in Table II. In this case, the alkoxysilanes used are listed in Table I and the solvents used are listed in Table III.

[0053]

[Table I]

Partially fluorinated hydrocarbon type lubricants used

Lubricant	Structural formula
Compound 1	CF_3 $\text{CF}_3\text{O}(\text{CFCF}_2\text{O})_1\text{CF}_2\text{CONHC}_3\text{H}_7\text{Si}(\text{OC}_2\text{H}_5)_3$
Compound 2	$(\text{C}_2\text{H}_5\text{O})_3\text{SiC}_3\text{H}_7\text{NHCOCF}_2\text{O}(\text{CF}_2\text{O})_n(\text{CF}_2\text{CF}_2\text{O})_m\text{CF}_2\text{CONHC}_3\text{H}_7\text{Si}(\text{OC}_2\text{H}_5)_3$

[0054]

[Table II]

Measurement results for wear resistance and contact angle

	Solvent	Lubricant	Soil resistance		Surface slipperiness		Wear resistance test		Coating uniformity		Contact angle (degrees)	
			Before	After	Before	After	Before	After	Before	After	Before	After
Appl. Ex. 1	1	Compound 1	○	○	○	○	○	○	○	○	115	92
Appl. Ex. 2	2	Compound 1	○	○	○	○	○	○	○	○	113	93
Appl. Ex. 3	3	Compound 1	○	○	○	○	○	○	○	○	116	94
Appl. Ex. 4	4	Compound 1	○	○	○	○	○	○	○	○	112	92
Appl. Ex. 5	5	Compound 2	○	○	○	○	○	○	○	○	110	91
Appl. Ex. 6	6	Compound 2	○	○	○	○	○	○	○	○	111	91
Appl. Ex. 7	7	Compound 2	○	○	○	○	○	○	○	○	111	91
Appl. Ex. 8	8	Compound 2	○	○	○	○	○	○	○	○	111	92
Comp. Ex. 1	9	Compound 1	○	○	Δ	○	○	○	Δ	Δ	110	88
Comp. Ex. 2	10	Compound 2	Δ	○	Δ	○	○	○	Δ	Δ	106	86
Comp. Ex. 3	11	Compound 2	Δ	○	Δ	○	○	○	x	Δ	107	86
Comp. Ex. 4	12	Compound 2	Δ	○	Δ	○	Δ	○	x	x	104	85

* Before cleaning with alcohol

** After cleaning with alcohol

[0055]

[Table III]

Solvents used

	Solvent	Boiling point (°C)	Viscosity (cps)	Structural formula
Solvent 1	Methanol	65	0.59	CH_3OH
Solvent 2	Ethanol	78	1.22	$\text{CH}_3\text{CH}_2\text{OH}$
Solvent 3	n-propanol	97	2.23	$\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$
Solvent 4	i-propanol	82	2.41	$\text{CH}_3\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$
Solvent 5	sec-butyl alcohol	98.8	2.88	$\text{CH}_3\text{CH}_2\text{CHOHCH}_3$
Solvent 6	sec-amyl alcohol	102	3.7	$(\text{CH}_3)_2\text{COHCH}_2\text{CH}_3$
Solvent 7	i-butyl alcohol	108	3.98	$(\text{CH}_3)_2\text{CHCH}_2\text{OH}$
Solvent 8	n-butyl alcohol	118	2.96	$\text{CH}_3(\text{CH}_2)_3\text{OH}$
Solvent 9	Diethyl carbinol	116	5.10	$\text{CH}_3\text{CH}_2\text{CHOHCH}_2\text{CH}_3$
Solvent 10	Activated amyl alcohol	128	5.09	$\text{CH}_3\text{CH}_2\text{CH}(\text{CH}_3)\text{CH}_2\text{OH}$
Solvent 11	i-amyl alcohol	131	3.56	$(\text{CH}_3)_2\text{CHCH}_2\text{OH}$
Solvent 12	n-amyl alcohol	138	3.31	$\text{CH}_3(\text{CH}_2)_4\text{OH}$

[0056]

[Effect of the invention] As described above, the filter of the present invention is a filter used for displays, in which the surface of a single layer or multilayer antireflective film formed on a plastic substrate is coated with a surface-modification film made of an alkoxysilane containing a fluoroalkyl group or perfluoropolyether group shown in general formula (I). Therefore, the filter of the present invention and display having said filter have the advantages described below.

- (1) Soiling based on fingerprints and hand smudges are less likely to occur. The above-mentioned effect can be permanently maintained.
- (2) Adsorption of water and water marks formed after drying can be easily removed.

- (3) Excellent slipperiness of the surface can be achieved.
- (4) Soiling based on dust, etc. is less likely to form and handling is easy.
- (5) Excellent wear resistance can be achieved.
- (6) It is possible to reduce the drying temperature after coating to 50°C or below.

[0057] Furthermore, the above-mentioned alkoxysilane is an alkoxysilane having a perfluoropolyether group, and when a filter with the surface-modification film produced by coating the above-mentioned compound diluted with a solvent having a boiling point of 50~120°C and a viscosity in the range of 0.5~4.0 cps at 20°C and a plastic substrate are used, the above-mentioned effect can be achieved; furthermore, because of the reduced degree of coating irregularities, the yield can be improved and beautiful and pleasant effect can be achieved.

[Brief description of the figures]

[Fig. 1] Fig. 1 shows a cross-section of the structure of the filter used for displays of an application example of the present invention.

[Fig. 2] Fig. 2 shows a perspective view diagram of a CRT of concerning in the application of the present invention.

[Explanation of codes]

1: Plastic substrate

2: Antireflective film

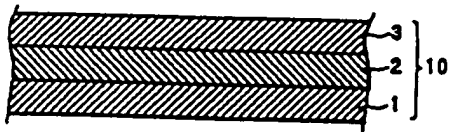
3: Surface-modification film

10: Filter

100: CRT

101: Panel

[Fig. 1]



[Fig. 2]

